Dark Matter in Galaxies
IAU Symposium, Vol. 220, 2004
S.D. Ryder, D.J. Pisano, M.A. Walker, and K.C. Freeman, eds.

Mapping the Remote Milky Way Halo using BHB stars at 70 < r < 130 kpc

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Abstract. We increase the number of remote halo tracers by using blue horizontal branch (BHB) stars out to Galactocentric distances of 130 kpc. We use SDSS EDR photometry and the VLT to detect 16 BHB stars at Galactocentric distances 70 <r < 130 kpc, and to measure their radial velocities. We find the mass of the Milky Way is $M = 1.7^{+3.0}_{-0.6} \times 10^{12} M_{\odot}$. When completed this survey will: (i) substantially reduce the errors in the total mass and extent of the Milky Way halo, and (ii) map the velocity space in a hitherto unexplored region of the halo.

1. Introduction

The total masses and sizes of all galaxies are poorly determined quantities – because we do not have suitable dynamical tracers at sufficiently large radii. The accurate measurement of the mass profile provides important clues to the nature of the dark matter. The Milky Way is the prime target for an accurate measurement. Wilkinson & Evans (1999, hereafter WE99) calculate the total mass of the Milky Way to be $M_{tot} = 1.9^{+3.6}_{-1.7} \times 10^{12} M_{\odot}$, using the full set of 27 known satellite galaxies and globular clusters (hereafter satellites) at Galactocentric radii $r > 20$ kpc (six possess measured proper motions). The large errors are primarily a consequence of the small number of satellites. The sample must be nearly complete, so a new population of distant halo objects must be found in order to increase the number of dynamical tracers. This motivates a new survey for remote halo tracers at large Galactocentric distances.

2. Isolating BHB stars at $70 < r < 130$ kpc

We have solved the problem of how to find large numbers of BHB stars in the remote halo, and have begun a VLT programme to measure the kinematics of the

https://doi.org/10.1017/S0074180900183238 Published online by Cambridge University Press

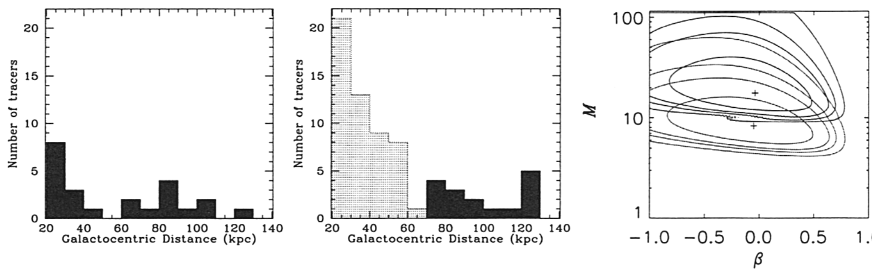

Figure 1. The *left plot* is a histogram of the 23 satellites at Galactocentric distances of $20 < r < 130$ kpc. The *middle plot* shows 51 BHB stars at distances $20 < r < 70$ kpc made from our previous study (Clewley 2002) and 16 BHB stars at $70 < r < 130$ kpc made using SDSS and the VLT. The *right plot* shows the resultant likelihood contours for the mass, M (in $10^{11} M_{\odot}$) and the velocity anisotropy, β for the combined data shown in both histograms using the WE99 model. Contours are enclosed probabilities of 68%, 90%, 95% and 99% including Leo I (upper curves) and excluding Leo I (lower curves).

population. The procedure involves three steps. First, we use $u * g * r*$ photometry from the SDSS database to detect A-type stars at high-Galactic latitude. These stars are either BHB stars ($M_B = 0.7$, luminous standard candles) or blue stragglers which are ~ 2 mag. less luminous. Second, we reduce the number of blue stragglers and increase the probability of good classification by limiting the colour ranges to $1.4 > (u * -g*) > 1.1$ and $-0.04 > (g * -r*) > -0.2$. Finally, using spectroscopy described in Clewley et al. (2002), we are able to efficiently separate the two populations. We consistently find that about half of our target A-type stars are BHB stars. Figure 1 (middle) shows the increase of distant halo tracers at Galactocentric distances of $20 < r < 130$ kpc from 23 (left) to 90.

3. The mass of the Milky Way

Preliminary results from the VLT are extremely encouraging. We have successfully isolated 16 BHB stars in the Galactocentric distance range of 70 to 130 kpc from a target sample of 31 candidates. With this small programme we have nearly doubled the number of tracers known at $r > 70$ kpc. Combined with the 23 satellites and 51 BHB stars at distances 20 to 60 kpc (from previous work at the AAT and WHT) we find the mass of the Milky Way is $M = 1.7^{+3.0}_{-0.6} \times 10^{12} M_{\odot}$.

References

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https://doi.org/10.1017/S0074180900183238 Published online by Cambridge University Press